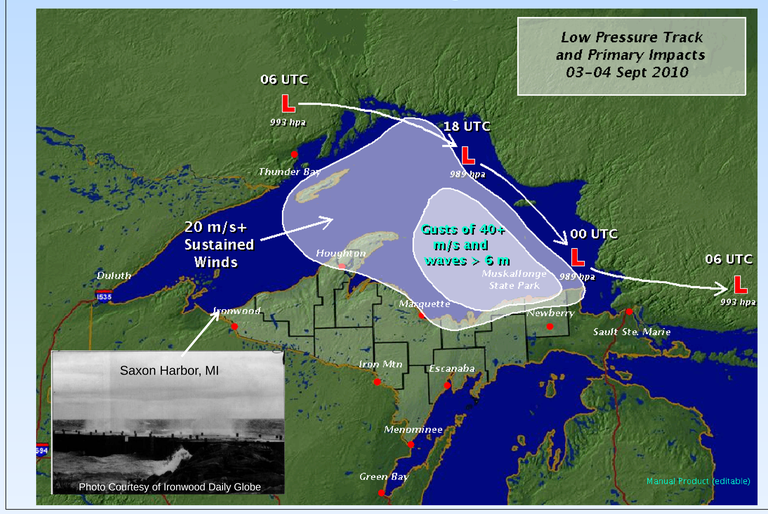
The Gales of September? Analysis and Customer Impacts of the 03-04 September High Wind Event across Lake Superior

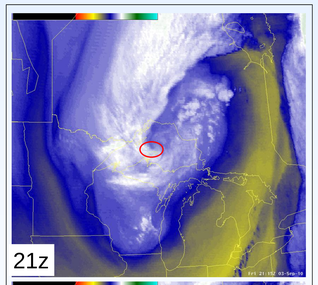
Michael Dutter
NOAA/National Weather Service – Marquette, MI
michael.dutter@noaa.gov http://weather.gov/Marquette

Event Overview

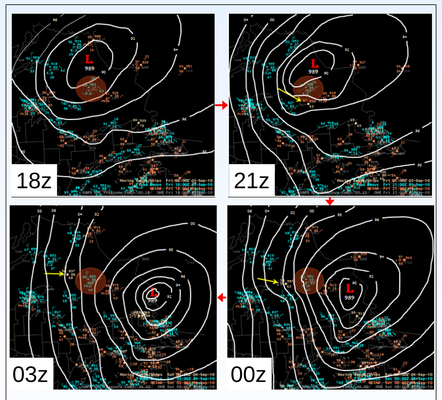
The Upper Midwest Autumn storm season started early in 2010, as a dangerous early season wind storm affected eastern Lake Superior and parts of central and eastern Upper Michigan.

On September 03-04, 2010, an intense cyclone moved along the Canadian shoreline of Lake Superior. Significant winds, with gusts as high as hurricane force, as well as 7+ m waves, affected much of central and eastern Lake Superior, impacting commerce across much of the lake and causing significant damage to parts of Eastern Upper Michigan near Lake Superior. This storm is arguably the strongest September storm in the past 30 years, as many wind and wave records were broken or nearly broken.

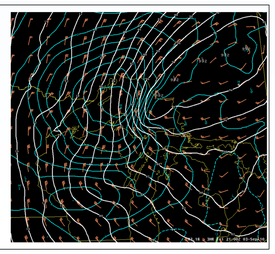




Water Vapor Imagery at 21z and 00z. The red oval notes the dry intrusion and possible sting jet (Browning 2004)

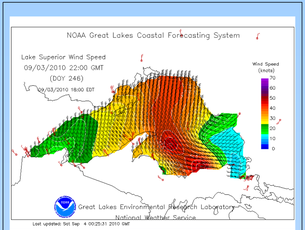


Manual MSLP analysis and surface observations.

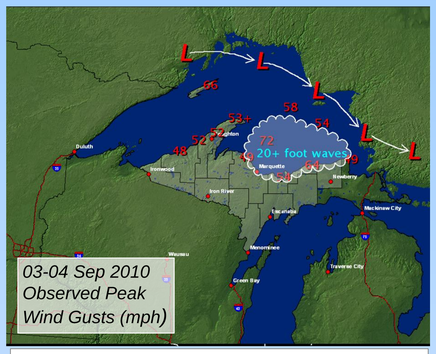


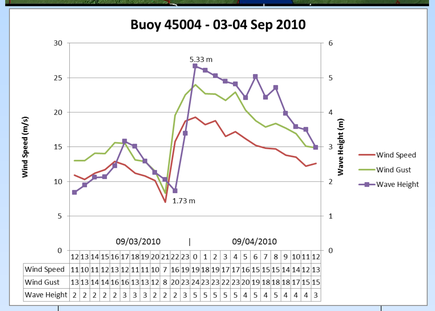
1000 hPA Geostrophic Wind (kt) /MSLP (hPA) / and 3 hr Pres Change (hPA) – NAM 3hr Fcst Valid 03/21z

Observations During the Event



Wind (top) and Significant Wave (bottom) analysis at 22z and 03z respectively (courtesy of the Great Lakes Environmental Research Laboratory.) Note the core of winds of 24+ m/s east of the Keweenaw Peninsula and near Grand Marais, MI, as well as the 6+ m wave heights just north of Munising.



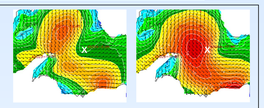


Time Series of Wind Speed, Wind Gust and Wave Height from buoy 45004. Note the 3.6 m increase of waves in 2 hours behind the trough passage.

	Stannard Rock(STDM4)		Eastern Buoy (45005)	
Record Type	Max on 9/3/10	Old Record (kt)	Max on 9/3/10	Old Record (kt)
Sustained Wind Speed	58.1 kt	50.7 (9/20/03)	36.9 kt	36.2 (9/20/03)
Peak Wind Gusts at Observation	62.0 kt	56.8 (9/28/92)	48.7 kt	43.2 (9/28/92)
Peak Wind over Previous Hour	63.0 kt	62.2 (9/22/01)	50.5 kt	46.9 (9/20/03)
Wave Height	--	--	17.4 ft	17.7 ft (9/20/03)

September Wind and Wave Records broken or nearly broken on 03-04 Sept 2010 --Broke all time record Peak Wind Record (6/1997)

GLERL wave analysis from 22z (left and 00z (right). 𝕏 marks 45004.

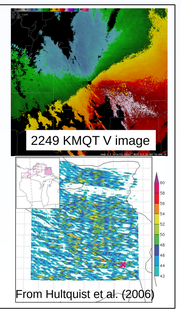


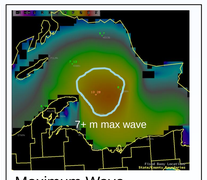
M/V Indiana Harbor

The Indiana Harbor experienced some of the worst conditions as it slowly traversed northward just east of Manitou Island. The ship experienced damage to deck rails and equipment, and saw green water on deck. The ship observed 25+ m/s sustained winds for much of the late afternoon and evening hours, while seeing 7-8 m waves. In addition, instant wind speeds of 50+ m/s were observed (upper right picture – note the values are in MPH). Note that the wind instrumentation on the ship is at 38 m above lake level.

Due to the extreme forecast, many ships opted to seek safety in Whitefish Bay, Bete Grise Bay, and to the lee of the MN shoreline. (image courtesy GLERL)

What about that 49 m/s wind observed by the Indiana Harbor? it is quite possible that the ship was experiencing intense horizontal convective rolls as documented in a re-examination of the Edmund Fitzgerald Sinking (Hultquist, Dutter, Schwab 2006).





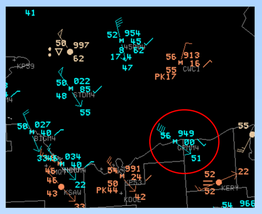
Maximum Wave Calculation based on the Rayleigh Distribution (Hmax=1.272*Hs) confirms wave heights observed by the Indiana Harbor.

Muskallonge State Park

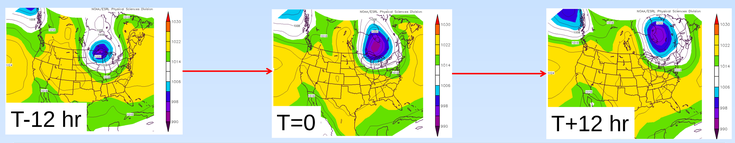
Situated along the Lake Superior shoreline in Luce County, MI, Muskallonge State Park received EF-1 type damage to trees and structures. Wind gusts at the park were estimated to be as high as 95 kt. Due to decisive action from park officials, no fatalities occurred and only a few minor injuries were reported. However, significant damage occurred, including:

- 122 downed trees in use areas
- 3 campers damaged
- 2 vehicles destroyed
- 1 electrical pedestal with minor damage

It is understandable why the park received such significant damage. The Grand Marais observing station reported wind gusts in excess of 25 m/s for nearly 7 hours, with a peak of 28.8 m/s at 0140 UTC.



"Typical" High Wind Low Track for Upper Michigan



Composite analysis of 15 high wind events across Upper Michigan (image creation courtesy NOAA/ESRL) using North American Regional Reanalysis (NARR) Dataset (Mesinger et al. 2004) from 1995-2008 shows that the low pressure usually moves from Wisconsin, across Lake Superior, then to James Bay by 12 hours after the onset of high winds in Upper Michigan.

Support Activities by NWS Marquette

Despite model discrepancies and a low pressure track normally not favorable for extreme and damaging winds across Lake Superior and Upper Michigan, forecasters at the NWS office in Marquette were diligent in ensuring that the public were made aware of potential hazards associated with the high winds. These actions likely helped save lives, and minimized major injuries.

Decision Support Actions by NWS Marquette included:

- High end Gale Warning, then Storm Warning issued
- Frequent Marine Weather Statements
- Discussions with U.S. Coast Guard so that they may inform any ships on the lake
- Collaboration with Environment Canada
- Contacting ships directly
- Use of the 800 MHZ radio to talk to Luce County Emergency Officials

MARINE WEATHER STATEMENT
NATIONAL WEATHER SERVICE MARQUETTE MI
248 PM EDT FRI SEP 3 2010

...STORM FORCE GUSTS POSSIBLE THIS AFTERNOON INTO EARLY THIS EVENING...

AS LOW PRESSURE OVER EASTERN LAKE SUPERIOR MOVES INTO ONTARIO...STRONG NORTH TO NORTHWEST WINDS WILL DEVELOP ACROSS CENTRAL AND EASTERN LAKE SUPERIOR. STORM FORCE WIND GUSTS TO 50 KNOTS ARE POSSIBLE THROUGH THE AFTERNOON BEFORE SUBSIDING LATER THIS EVENING. AT 224 PM EDT...THE OBSERVING SITE AT OJIBWAY ON ISLE ROYALE REPORTED A WIND GUST OF 54 KNOTS.

MONITOR NOAA WEATHER RADIO FOR THE LATEST INFORMATION...FORECASTS...AND WARNINGS ON THIS DEVELOPING SITUATION.